

This method has been tested and found to give results which agree closely with those obtained by the more laborious method applied to the case of the plane with one bend.

The Difference between the Magnetic Diurnal Variations on Ordinary and Quiet Days at Kew Observatory.

By C. CHREE, Sc.D., LL.D., F.R.S.

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§ 1. While investigating the nature of the diurnal inequality of the magnetic elements at Kew Observatory, I have discovered a somewhat remarkable relationship between the inequalities derived respectively from quiet days and from ordinary days (*i.e.* all days except those of large disturbance). The period whose records were employed consisted of the 11 years 1890 to 1900. During that period five days were selected for each month by the Astronomer Royal as typical of quiet conditions. An analysis of the diurnal inequalities at Kew on these quiet days was given in an earlier paper.* Use is also made of the diurnal inequalities† derived from 209 disturbed days, being the days of principal disturbance from 1890 to 1900. The new material employed consists of diurnal inequalities based on all the days of the 11 years, excluding the 209 highly disturbed days but including the quiet days. The cost of measuring the curves was defrayed by a grant from the Government Grant Committee.

The diurnal variation in the horizontal components of magnetic force is often advantageously studied by considering the vector which represents the force to whose action the departure from the mean value for the day may be ascribed.

In the figure NS and WE are perpendicular lines, respectively in and perpendicular to the geographical meridian. If OM and PM, the co-ordinates of the point P, are respectively proportional to the departures of the east and north components of force at any given hour from their mean values for the day, OP represents in magnitude and direction the force to which the diurnal variation in the horizontal plane may be ascribed. The successive positions occupied by P throughout the 24 hours constitute what is known as the vector diagram.

* 'Phil. Trans.,' A, vol. 202, p. 335.

† 'Phil. Trans.,' A, vol. 210, p. 210.

Suppose now that P and P' are corresponding points on the vector diagrams which belong respectively to quiet and to ordinary days, then by ordinary statics PP' represents in magnitude and direction the force to which may be ascribed the difference between the ordinary day and the quiet day variations.

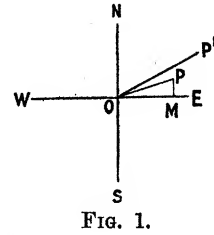


FIG. 1.

Fig. 2 shows the variations in PP' throughout the 24 hours, in the case of the mean diurnal inequality for the whole year, as exhibited by the 11 years 1890 to 1900 combined. O is the origin. The arms of the cross, which are oriented N.S. and E.W., each represent 2γ ($1\gamma \equiv 1 \times 10^{-5}$ C.G.S.). The hours are shown adjacent to the points to which they refer. The arrow in each case is drawn from the point on the quiet day diagram to the point on the ordinary day diagram. To avoid complicating the figure, the vector diagrams themselves are omitted. The

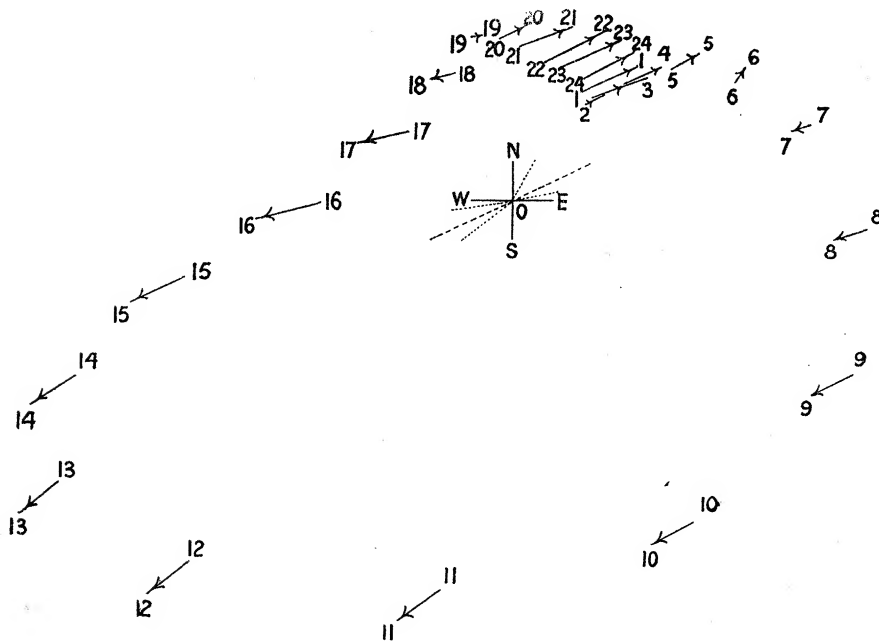


FIG. 2.

difference vectors answering to 2, 3 and 4 A.M. are partly superposed, so that only one extremity of each line is clearly visible.

The phenomenon to which I principally call attention is embodied in the fact that the difference vector lines, instead of being oriented promiscuously, show a marked approach to a common direction. The dotted lines through O show the limiting orientations of the difference vector lines. In the S.W.

quadrant the angle between the extreme directions is only 29° . In the N.E. quadrant it is 49° . If, however, we omit 6 A.M., when the difference vector was only 0.7γ , the latter angle reduces to 16° . The difference vector vanished between hours 6 and 7, and again between hours 18 and 19 (*i.e.* 6 and 7 P.M.), and the angles it swung through in these two hours were respectively 133° and 175° . Further, the largest value of the difference vector throughout the 24 hours was only 3.3γ . In view of these circumstances, the smallness in the variations exhibited by the direction of the vector is truly surprising. The broken line in fig. 2—which is inclined at 64° to the meridian—represents the direction to which the 24 vector difference lines most closely approach. Two calculations were made of its position. The first took simply the arithmetic mean of the inclinations to NS, 180° being subtracted from all angles in the S.W. quadrant; the second weighted the angles according to the magnitude of the difference vector. The results of the two calculations, $63^\circ.96$ and $64^\circ.06$, agreed so closely that it seemed unnecessary to employ any more mathematically rigid method of calculation. The perpendicular to the broken line, *i.e.* a line oriented 26° west of north, would practically represent the direction along which the component of the difference vector is a minimum.

§ 2. It is natural to regard the difference between ordinary day and quiet day inequalities as due to the influence of disturbance upon the former. This suggests enquiry into the nature of the difference between disturbed and quiet day inequalities. The necessary calculations had been made in a previous paper,* the results of which are shown graphically in fig. 3. This figure, it should be noticed, is drawn on a different plan from fig. 2. The difference between the disturbed and quiet day vectors is very large, and, owing doubtless in great measure to the small number of disturbed days, the hourly differences are somewhat irregular (to get smooth results thousands of disturbed days would have been required instead of 209).

Thus a diagram constructed on the plan of fig. 2, unless drawn on a very large scale, would have failed to show the results clearly. In fig. 3 lines drawn from O to the points marked 1, 2, ..., 24 would represent in magnitude and direction the difference vector (disturbed less quiet day) at hours 1 to 24 respectively, *i.e.* the lines corresponding to PP' in fig. 2, if P' now lay on the vector diagram for highly disturbed days. The lines have not been actually drawn, as some of them could hardly be shown separately, and the eye can readily supply the deficiency. The broken line represents, as in fig. 2, the inclination of 64° to the meridian. The arms of the cross represent each 2γ .

* 'Phil. Trans.,' A, vol. 210, p. 300.

Fig. 3 admittedly shows much greater variability in the vectorial direction than fig. 2. At the same time there is a remarkable gap between the

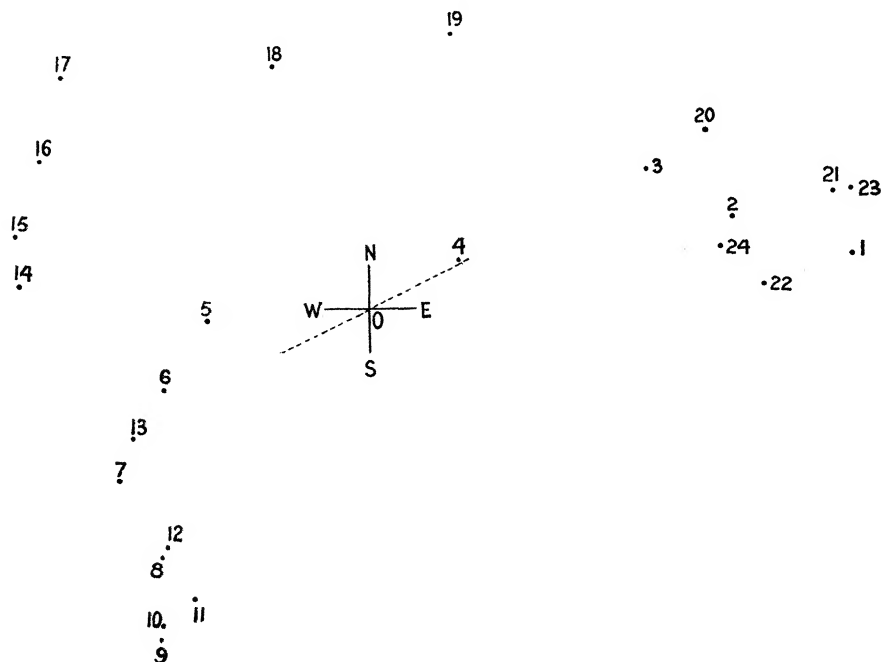


FIG. 3.

direction of the vector at 22 h. (86° east of north) and that at 11 h. (211° east of north). Again, between 4 and 5 h. the vector in vanishing swings through 153° . The vector is included in the N.E. and S.W. quadrants except from 2 to 6 P.M. It is during these afternoon hours that the difference between the phenomena exhibited in figs. 2 and 3 mainly exists. In fig. 2 the vector swung through 175° between 6 and 7 P.M., whereas in fig. 3 it took from 1 to 8 P.M. to swing through 180° . Whether the differences between figs. 2 and 3 would be reduced if an adequate number of highly disturbed days were available it is, of course, impossible to say. At all events the points of resemblance between the two figures are by no means insignificant.

§ 3. Table I gives the data on which figs. 2 and 3 are based, and also the corresponding variations in the vertical force; $o-q$ means ordinary less quiet day vector, and $d-q$ disturbed less quiet day vector. The $d-q$ results, as already indicated, are quoted from a previous paper.

Table I.—Diurnal Inequality. Difference Vector.

Hour (G.M.T.).	o-q Difference vector.				d-q Difference vector.			
	ϕ .	θ .	ρ .	R.	ϕ .	θ .	ρ .	R.
	°	°	γ	γ	°	°	γ	γ
1	65	117	3.1	3.5	84	131	21.4	28.5
2	66	124	3.0	3.6	76	143	16.6	27.3
3	69	128	2.8	3.6	64	149	13.7	26.4
4	66	136	2.2	3.2	59	172	3.7	26.1
5	60	144	1.6	2.7	266	164	7.2	26.3
6	27	161	0.7	2.1	249	157	9.7	25.3
7	254	159	0.7	2.0	236	144	13.4	22.5
8	252	133	1.6	2.2	220	135	14.3	20.1
9	243	120	2.2	2.6	213	120	17.2	19.9
10	242	109	2.4	2.5	213	107	16.7	17.5
11	234	96	2.7	2.7	211	89	15.0	15.0
12	231	88	2.6	2.6	221	73	13.8	14.4
13	232	81	2.4	2.5	242	50	12.0	15.7
14	238	71	2.8	3.0	274	42	15.5	23.1
15	245	66	3.1	3.4	282	32	16.0	30.0
16	256	58	3.2	3.8	294	26	16.1	37.1
17	259	44	2.5	3.6	307	27	17.1	37.7
18	261	21	1.2	3.3	338	20	11.4	33.7
19	76	8	0.4	2.8	17	26	12.6	29.1
20	62	29	1.5	3.1	62	46	17.2	23.6
21	69	53	2.6	3.2	76	67	21.1	22.9
22	61	75	3.3	3.4	86	96	17.5	17.6
23	65	90	3.3	3.3	76	106	21.8	22.7
24	62	105	3.0	3.1	80	132	15.8	21.5
Mean from 24 hours			2.29	2.99	—		14.9	24.3
„ day hours			2.26	2.80	—		14.8	23.5
„ night hours			2.31	3.18	—		14.9	25.1

ΔN , ΔE , and ΔV being the north, east, and vertical components of the difference vector, the remaining notation is shown by the equations

$$\rho = \sqrt{(\Delta N^2 + \Delta E^2)}.$$

$$R = \sqrt{(\Delta N^2 + \Delta E^2 + \Delta V^2)}.$$

$$\phi = \tan^{-1}(\Delta E/\Delta N).$$

$$\theta = \tan^{-1}(\rho/\Delta V).$$

R is the resultant difference vector, ρ its horizontal component, ϕ the inclination of ρ to the meridian measured from north to south through east, and θ the inclination of R to the downwardly directed vertical.

The limits to “day” and “night” in Table I are the hours 6 and 18. The fact that the night means of ρ and R actually exceed the day means is remarkable, in view of the large excess of the day means over the night

means in the case of the ordinary vectors, whether for quiet, ordinary, or disturbed days.

The vector is directed above or below ground according as θ is greater or less than 90° . In the case of the $o-q$ vector the time when the vector is below ground nearly coincides with the afternoon.

§ 4. In view of the approach of the horizontal component of the $o-q$ vector to the fixed direction 64° east of north, it seemed desirable to ascertain the variation throughout the 24 hours in its components—say X and Y—along and perpendicular to this direction. It seemed also desirable that these components should be represented in terms of Fourier series with periods 24, 12, etc., hours. The two ends were most readily secured by utilising results already calculated for the horizontal force (H) and declination (D) inequalities.

Representing the $o-q$ difference inequalities in H and D by the series

$$\begin{aligned}\Delta H &= \Sigma (a_n \cos nt + b_n \sin nt), \\ \Delta D &= \Sigma (a'_n \cos nt + b'_n \sin nt),\end{aligned}$$

where t represents the equivalent angle (at 15° per hour) to the time elapsed since Greenwich midnight, the component of the horizontal difference vector inclined at any angle ψ to the magnetic meridian (or direction of ΔH) is

$$\Sigma \{(a_n \cos \psi + a'_n \sin \psi) \cos nt + (b_n \cos \psi + b'_n \sin \psi) \sin nt\}.$$

Here ΔD is supposed to be expressed in terms of 1γ as unit, which means, for the place and epoch considered, writing 5.32γ as the equivalent of $1'$.

The mean declination at Kew for the eleven years 1890–1900 was 17.3° W., so that, to get the component called Y above, we must write 8.7° for ψ , and similarly for X.

The results finally obtained for X, Y, and the vertical component of the $o-q$ vector, in terms of 1γ as unit, were as follows:—

$$\begin{aligned}X &= 3.32 \sin(t + 80^\circ) + 0.41 \sin(2t + 119^\circ) + 0.55 \sin(3t + 240^\circ) \\ &\quad + 0.07 \sin(4t + 49^\circ), \quad (1)\end{aligned}$$

$$\begin{aligned}Y &= 0.09 \sin(t + 146^\circ) + 0.28 \sin(2t + 273^\circ) + 0.23 \sin(3t + 87^\circ) \\ &\quad + 0.14 \sin(4t + 158^\circ), \quad (2)\end{aligned}$$

$$\begin{aligned}\Delta V &= 2.47 \sin(t + 188^\circ) + 0.56 \sin(2t + 230^\circ) + 0.15 \sin(3t + 293^\circ) \\ &\quad + 0.04 \sin(4t + 90^\circ). \quad (3)\end{aligned}$$

The fact that Y is insignificant was, of course, implied by fig. 2, but it is interesting to find that the 24-hour term in it is especially insignificant, while the 24-hour term in X dominates all the others. The 24-hour term in ΔV is also largely dominant, so that the $o-q$ difference vector is essentially a phenomenon of a regular kind with a 24-hour period.

Phase angles in cases where the amplitude is very small can hardly claim a very high precision. Thus it may be a pure accident, though a somewhat remarkable one, that the two largest terms in (1) can be written in the form

$$3.32 (\sin \chi + \frac{1}{6} \sin 3\chi),$$

where $\chi = t + 80^\circ$.

$\sin \chi$ assumes its extreme values when $t + 80^\circ$ equals 90° or 270° . This means 40 minutes after midnight and noon respectively.

§ 5. The mean diurnal inequality for the whole year, derived from 11 years combined, may represent a blend of widely divergent characters. In the case alike of the ordinary and quiet days, the diurnal inequality varies much in amplitude and sensibly in type throughout the year. Amplitude and type also vary from year to year with sunspot frequency. It was thus desirable to ascertain whether the phenomenon apparent in fig. 2 varies with the greater or less frequency of sunspots, and whether it holds good of individual months of the year. Attention must first be called to the limitations imposed by the character of the data. The $o-q$ vector is of small amplitude, and any reduction in the number of days utilised must lead to less complete elimination of accidental features. In a single year's results accident might play a dominant part; accordingly, the years of largest sunspot frequency, 1892-1895, were combined in one group, and those of least sunspot frequency—1890, 1899, and 1900—in another group. For brevity, these groups will be termed years of sunspot maximum and minimum. The results obtained for the horizontal component of the $o-q$ vector for these two groups of years are given in Table II, the notation being the same as in Table I.

The vector for 19 h. in the sunspot minimum group falls in the S.E. quadrant, but the amplitude being only 0.2γ this has little real significance. If estimates are made of the mean direction of the difference vector in the same way as in the case of the whole 11 years, we get

	From arithmetic mean.	From weighted angles.
Sunspot maximum.....	$63^\circ.4$	$65^\circ.6$
Sunspot minimum	$70^\circ.2$	$66^\circ.4$

In the case of the sunspot minimum group the vector for 19 h. is nearly perpendicular to the dominant direction. If its angle 153° were replaced in the first calculation by -27° it would reduce the result to $62^\circ.7$, while if it were omitted entirely the result would become $66^\circ.6$.

The results from the two groups of years are naturally more erratic than those from the 11 years, but in neither case is there any systematic divergence

Table II.—Diurnal Inequality. $o-q$ Difference Vector.

Hour (G.M.T.).	Sunspot maximum.		Sunspot minimum.	
	ϕ .	ρ .	ϕ .	ρ .
	°	γ	°	γ
1	63	3.9	73	2.4
2	67	3.9	76	2.1
3	66	3.6	90	1.7
4	65	3.1	78	1.4
5	78	1.9	66	1.0
6	56	0.4	0	0.7
7	225	1.0	286	0.7
8	235	2.1	274	1.4
9	234	2.7	259	1.6
10	242	3.0	246	1.7
11	240	3.2	245	1.9
12	241	2.9	225	1.7
13	238	2.5	219	1.9
14	247	3.3	225	2.4
15	251	3.4	239	2.6
16	261	3.7	261	2.4
17	260	2.9	257	1.7
18	257	1.3	264	1.0
19	34	0.4	153	0.2
20	58	1.5	63	1.1
21	66	2.4	63	2.0
22	61	3.5	58	2.8
23	70	3.5	62	3.0
24	67	3.6	63	2.5
Mean from 24 hours	2.65	—	1.75	
„ day hours	2.63	—	1.74	
„ night hours	2.68	—	1.75	

between the angles and those deduced from the complete period. The only conspicuous difference between the sunspot maximum and minimum results is in the amplitude of the difference vector. The excess for the sunspot maximum group is in much the same proportion as in the case of the quiet day vector itself.

§ 6. The N. and W. quiet day inequalities were given in my previous paper only for March, June, and December, in addition to the year as a whole. Also, considering the irregularities in the results for the sunspot minimum year, which depended on 36 months' data, it seemed doubtful whether results depending on only 11 months' data would be satisfactory. It was thus decided to take not the 12 months but the three seasons, winter, equinox (*i.e.* March, April, September, and October), and summer. Each set of results thus depends on 11×4 or 44 individual months.

Fourier coefficients had been calculated in the case of the D and H inequalities for the three seasons, both for ordinary and quiet days. It was thus easy, in the way already illustrated, to obtain the components of the $o-g$ difference vector along any two perpendicular lines in the horizontal plane. The directions selected were 64° east of north and 26° west of north, regarded respectively as axes of x and y .

The following results were obtained:—

Winter—

$$X = 3.03 \sin(t + 82^\circ) + 0.44 \sin(2t + 155^\circ) + 0.23 \sin(3t + 229^\circ) \\ + 0.10 \sin(4t + 204^\circ), \quad (4)$$

$$Y = 1.45 \sin(t + 335^\circ) + 0.16 \sin(2t + 97^\circ) + 0.40 \sin(3t + 129^\circ) \\ + 0.10 \sin(4t + 156^\circ), \quad (5)$$

Equinox—

$$X = 4.18 \sin(t + 86^\circ) + 0.24 \sin(2t + 151^\circ) + 0.66 \sin(3t + 226^\circ) \\ + 0.28 \sin(4t + 75^\circ), \quad (6)$$

$$Y = 0.30 \sin(t + 64^\circ) + 0.36 \sin(2t + 275^\circ) + 0.38 \sin(3t + 110^\circ) \\ + 0.22 \sin(4t + 180^\circ), \quad (7)$$

Summer—

$$X = 2.83 \sin(t + 68^\circ) + 0.77 \sin(2t + 88^\circ) + 0.80 \sin(3t + 255^\circ) \\ + 0.16 \sin(4t + 333^\circ), \quad (8)$$

$$Y = 1.74 \sin(t + 162^\circ) + 0.69 \sin(2t + 274^\circ) + 0.41 \sin(3t + 12^\circ) \\ + 0.11 \sin(4t + 139^\circ). \quad (9)$$

In equinox the results are closely analogous to those for the year as a whole; the 24-hour term in X being largely dominant. But in winter and summer, while the 24-hour term in X is considerably the most important term, Y is not negligible compared with X .

The results might mean either that the approach of the difference vector to a dominant direction is much less apparent in the inequalities for winter and summer than in that for the whole year, or that, while there is a dominant direction, it varies with the season. It is easy to decide between the two alternatives.

Suppose $c_n \sin(nt + \alpha)$ and $c'_n \sin(nt + \alpha')$ represent the Fourier waves of a given period in the components of the diurnal inequality along x and y , then the Fourier wave of the same period in the component inclined at an angle ψ to the x -axis has its amplitude C given by

$$C^2 = \frac{1}{2}(c^2 + c'^2) + \frac{1}{2}(c^2 - c'^2) \cos 2\psi + cc' \cos(\alpha - \alpha') \sin 2\psi. \quad (10)$$

The directions making C a maximum or minimum are given by

$$\tan 2\psi = 2cc' \cos(\alpha - \alpha') / (c^2 - c'^2). \quad (11)$$

Taking more exact values for α_1 and α_1' than those recorded in (4), (5), (8), and (9), we have for winter

$$c_1 = 3.03\gamma, \quad c_1' = 1.45\gamma, \quad \alpha_1 \sim \alpha_1' = 106^\circ 39',$$

for summer

$$c_1 = 2.83\gamma, \quad c_1' = 1.74\gamma, \quad \alpha_1 \sim \alpha_1' = 93^\circ 27'.$$

Whence we find for winter

$$\left. \begin{array}{l} \psi = 170^\circ.2 \\ C = 3.07\gamma \end{array} \right\} \quad \text{and} \quad \left\{ \begin{array}{l} \psi = 80^\circ.2 \\ C = 1.37\gamma \end{array} \right.$$

for summer

$$\left. \begin{array}{l} \psi = 176^\circ.6 \\ C = 2.83\gamma \end{array} \right\} \quad \text{and} \quad \left\{ \begin{array}{l} \psi = 86^\circ.6 \\ C = 1.74\gamma \end{array} \right.$$

Thus, in both seasons the direction in which the 24-hour term is a maximum departs so little from 64° east of north that the differences between the maximum and minimum values of c_1 and those belonging respectively to X and Y are insignificant.

These results were borne out by an examination of the $o-q$ data for March, June, and December. In March, an equinoctial month, the vector lay in the S.W. quadrant from 8 h. to 18 h. Throughout the rest of the day except at 19 h. it lay in the N.E. quadrant. At 19 h. it lay in the S.E. quadrant, but its amplitude was only 0.8γ .

In June the vector at 5 h. and 6 h. lay in the S.E. quadrant, and from 16 h. to 20 h. it lay in the N.W. quadrant; during the remaining 17 hours it lay either in the N.E. or the S.W. quadrant.

In December the vector lay in the N.E. or S.W. quadrants during 19 hours, but was in the S.E. quadrant at 19 h. and 20 h., and in the N.W. quadrant at 6 h., 7 h., and 8 h.

In both June and December, while the N.E. and S.W. quadrants contained the vector during the greater part of the day, the deviation into the two other quadrants was too decided to be wholly accidental. The afternoon phenomena in June somewhat resembled those in the $d-q$ vector in fig. 3.

§ 7. One remarkable feature remains to be pointed out. The diurnal variation in days of any kind consists not merely of a periodic but also of a non-periodic part, the existence of the latter being evidenced by the non-cyclic change, *i.e.* the excess of the value at the second midnight over that at the first midnight of the representative day. Thus to complete our information as to the difference between the diurnal variations in ordinary and quiet days, we must consider the relation of the n.c. (non-cyclic) changes.

The apparent n.c. change in any element is composed of several parts. In addition to the secular change, and any true n.c. change characteristic of the

particular type of day, there is in general an instrumental contribution. This may be negligible, and ought at least to be very small in a declination magnetograph; but it may be considerable in a force, especially a vertical force, instrument. In all force instruments there is naturally a drift in one direction, due to change of magnetic moment or of rigidity in the suspension; and unless the magnetograph room has a constant temperature, or temperature compensation is complete, there is a shift of base line value, first in one direction then in the other, due to seasonal change of temperature. In individual days at Kew the apparent n.c. change in V is mainly a question of temperature. If one considers, however, not individual days or months but the whole year—based on as many as 11 years—temperature effects neutralise one another, even in V. Also, while the n.c. changes obtained for the average ordinary or quiet day may owe something to instrumental drift, any such contribution must be practically eliminated when we deal with the difference between the n.c. changes on the average ordinary and quiet days.

The mean n.c. change in ordinary days in D, H and V was found for each of the 132 months. This had been done before for quiet days. The final mean values are

	D.	H.	V.
Quiet day.....	+ 0·044'	+ 3·34 γ	- 0·84 γ
Ordinary day	- 0·030'	+ 0·80 γ	- 0·42 γ
$q-o$, n.c. change...	+ 0·074'	+ 2·54 γ	- 0·42 γ

The equivalent in force of 0·074' is 0·394 γ .

It will be noticed that we have given here the $q-o$ difference, as it happens to be more convenient for our subsequent geometrical work. The $o-q$ difference, of course, differs only in sign. Regarding the $q-o$ n.c. change as a vector quantity, its horizontal component is inclined to the magnetic meridian at the angle

$$\tan^{-1}(0\cdot394/2\cdot54), \text{ or } 8\cdot8^\circ.$$

The magnetic meridian being, as already stated, $17^\circ\cdot3$ west of north, the horizontal vector is thus inclined at $26^\circ\cdot1$ to the astronomical meridian. In short, it differs by less than the probable error of evaluation from perpendicularity to the line to which the $o-q$ difference inequality vector approaches. Thus what we have found is that the difference between the normal ordinary and quiet day diurnal variations in the horizontal plane consists, to a first approximation, of an oscillation of 24-hour period, along a line inclined 64° to

east of north, and of a change proceeding at a uniform rate throughout the 24 hours along a second line perpendicular to the first.

The resultant of the $q-o$ n.c. changes in D and H has an amplitude of 2.57γ , its components to north and west being respectively 2.31γ and 1.13γ . The resultant of the $q-o$ n.c. changes in D, H and V has an amplitude of 2.60γ and an inclination of $80^{\circ}.7$ to the upwardly directed vertical.

It is difficult to say whether the ordinary or the quiet day inequality has the greater claim to be regarded as the fundamental. The ordinary days averaged 346 a year, including all but the 209 highly disturbed days of the 11 years, but the inclusion of the omitted days would have had an appreciable influence. The exclusion, moreover, of any particular day was a purely arbitrary matter, except in so far as it was dictated by loss of trace. Some idea of the variability of the days treated as ordinary may be derived from the fact that when "character" figures were assigned to the 11 years, on the international scheme "0" (quiet), "1" (moderately disturbed), "2" (highly disturbed), the average year had 154 days "0," 167 days "1" and 44 days "2." Thus the 346 ordinary days of the average year included 25 (or 7 per cent.) of character "2," while nearly 45 per cent. of them were of character "0." In most months the five selected quiet days were quieter than the average day of character "0," but not conspicuously so. Thus the ordinary day inequality, if much more representative, is also of a much more hybrid character than the quiet day inequality.

If we were dealing at one time with the data of, say, 100 years, there would be much to be said for taking as the standard the inequality from all days of the year. But usually what we have to do with at one time are the data of one year, and one really first order disturbance may introduce into the diurnal inequality of the month it occurs in a large element, which can only be regarded as fortuitous, so far as the phenomena of the particular month are concerned. It might, for instance, make a notable difference whether Greenwich or local time was employed in the inequalities.

The main phenomenon of the n.c. change in quiet days at Kew, viz. the large increase in H, has been observed at other places. This suggests the probability that phenomena analogous to those now described may prove to hold good elsewhere. If this should be the case, the fundamental lines to which the phenomena are attached are presumably related in some way to some fundamental direction connected with the earth's magnetism. It is thus a suggestive fact that the vertical plane at Kew inclined at 26° to west of north comes at least near to containing the earth's north magnetic pole.
